Individual Differences in Children's Perception of Foreign-Accented Speech: The Role of Temperament

Undergraduate Research Thesis

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by

Sarah Mabie

The Ohio State University
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Project Advisor: Professor Rachael Frush Holt, Ph.D.,
Department of Speech and Hearing Science

Abstract

Individual differences in children's speech perception are large and have been partially attributed to differences in executive function (e.g., Lalonde & Holt, 2014), but much unexplained variability remains. Temperament is a potential influence that has been studied in related fields, such as stuttering (Eggers et al., 2010), but has been ignored as a contributing factor in children's speech perception. We investigated the influence of temperament on individual differences in children's perception of foreign-accented speech. Eighty-four 5- to 7-year-old monolingual English children were presented with 60 English sentences produced by either a native English or Mandarin talker (Wildcat Corpus; Van Engen et al., 2010) embedded in multi-talker babble at +8 dB SNR. For 30 sentences, the final (target) word was highly predictive from sentence context and for the other 30, it was not; the same final words appeared in both predictability conditions. Temperament was assessed with the very short form of the Children's Behavior Questionnaire (Putnam & Rothbart, 2006), which was completed by each child's parent/caregiver. Semantic context was of similar benefit to children in both the native and foreign-accent conditions. Children who scored high on Surgency (scales of positive emotion, reflecting a tendency to enjoy high-intensity activities) had poorer word recognition in both predictability conditions. These results preliminarily suggest that temperament contributes to individual differences in children's speech perception in that children who desire a high level of activity tend to perform more poorly on difficult speech perception tasks.

Keywords: foreign-accented speech, child temperament, speech perception

I. Introduction

On a daily basis, listeners must compensate for variability in speech signals. This variability has been attributed to idiolect differences, positional effects, speaking rate differences, and coarticulatory effects (Bent & Holt, 2013). Compared to native speech, foreign-accented speech differs in both segmental and suprasegmental domains (Bent & Holt, 2013). Segmental variability is displayed in phoneme additions, distortions, substitutions, and omissions (Bent & Holt, 2013), and can be based upon the phonological constraints of a speaker's native language (Adank, Evans, Stuart-Smith, & Scott, 2009). For example, Japanese learners of English often have difficulty discriminating between /l/ and /r/ due to the phonological constraints of Japanese (which does not contain this phonemic distinction). Suprasegmental variance includes word stress, intonation patterns, and rhythm (Adank et al., 2009; Bent & Holt, 2013). When listening to a nonnative speaker, listeners must compensate for these segmental and suprasegmental variances (Adank et al., 2009). The result is that adults' recognition of foreign-accented speech is poorer than the recognition of native speech, especially in background noise (Adank et al., 2009; Munro & Derwing, 1995; Rogers, Dalby, & Nishi, 2004). For example, Munro and Derwing (1995) reported that native English listeners make more speech recognition errors and show longer response times when listening to nonnative speakers of English.

Background Noise Effects

The presence of background noise is particularly detrimental to the perception of foreign-accented speech (Adank et al., 2009). Rogers et al. (2004) found a correlation between adverse listening conditions and the perception of foreign-accented speech when comparing the intelligibility of native English sentences and Mandarin-accented English sentences. Sentences were presented in quiet and at three signal-to-noise ratios (SNRs) (+10 dB, 0 dB, and -5 dB).

Intelligibility was measured as a proportion of correctly identified target words. Whereas the addition of noise was detrimental in both native and nonnative conditions, noise showed substantially greater detriments to the perception of Mandarin-accented sentences compared to native English sentences. It was also found that an increasingly poor SNRs caused greater degradations to intelligibility in the nonnative condition compared to the native condition. Adank et al. (2009) found a similar influence of background noise on native dialectal variations. When sentences of the Glaswegian English (GE) dialect of Scotland were presented in moderately adverse listening conditions of +3 dB and 0 dB SNR, speakers of the Standard English (SE) dialect of England were slower to give correct responses in comparison to presentations of SE dialect sentences (SE speakers self-reported little to no experience with GE speakers prior to the study). This delay in response reflects additional processing costs placed on the listener when compensating for dialectal differences.

Developmental Effects

There is also a benefit of age (or experience) on perceiving foreign-accented speech. Bent (2014) found that adults perform better than children [4;0 to 7;7 (years;months)] on native and foreign-accented word identification tasks. In this experiment, both age groups were exposed to either a native speaker of American English or a native speaker of Korean. Within each condition, half of the words were lexically "easy" and half were lexically "hard." Lexical difficulty was defined by word frequency and neighborhood density according to the Neighborhood Activation Model of spoken word recognition (Luce & Pisoni, 1998). Sentences were embedded in a speech-shaped noise masker at a +5 dB SNR. Participants were asked to repeat the word they heard. Results showed that adults performed better than children, stimuli produced by the native speaker were correctly identified more often than the non-native speaker stimuli, and the lexically easy

words were identified correctly more often than the lexically hard words. An interaction between lexical difficulty and age was also significant. This was due to adults showing a larger benefit between the lexically easy and hard words than child listeners. In addition, Bent (2014) found that children's perception of foreign-accented speech improved with age. This suggests that foreign-accented speech perception improves during this developmental time period.

Context Effects

Another area of interest is whether listeners benefit from semantic context when listening to a nonnative speaker, specifically in comparison to perception of a native speaker. It is easier to identify words in a sentence if they are semantically predictable from the preceding context (Duffy & Giolas, 1974; Kalikow, Stevens, & Elliot, 1977). For example, identification of the word 'cake' is easier in a sentence like "He blew out the candles on the birthday cake" than "He talked about the cake." The semantic context effect is reduced, however, at poor SNRs (Kalikow et al., 1977). Clopper (2012) reported that English sentences presented in noise ending in high-predictability words were more intelligible than the low-predictability target words for adult listeners. This shows that a poor SNR did not completely eliminate listeners' reliance on semantic cues. However, when the talker dialect was less familiar, the listeners relied less on semantic information (Clopper, 2012). According to the cue-weighting model of speech perception (Mattys, White, & Melhorn, 2005), different cues are used in easy and hard listening situations. For instance, Mattys et al. (2005) found that in easy listening conditions, listeners rely on lexical and semantic cues more than segmental cues, whereas in difficult listening conditions, listeners rely more on segmental cues than lexical and semantic ones. In addition, Bradlow and Alexander (2008) found that the benefit of semantic context is different for native and nonnative English speaking listeners. English sentences produced in either plain or clear speech, with the final target word either predictable or

not predictable from context, were presented in noise to native and nonnative adult English listeners. Results revealed that, whereas native listeners benefitted from the acoustic and semantic enhancements separately and in combination, nonnative listeners' word recognition only improved when both enhancements were available. The results of this study suggest that whereas native and nonnative listeners apply similar strategies for speech-in-noise perception, nonnative listeners require more favorable signal clarity in order for contextual information to be of benefit.

Recent work has investigated children's use of semantic cues in degraded listening conditions for native speech. Fallon, Trehub, and Schneider (2002) compared 5-year-olds', 9-year-olds', and adults' accuracy in identifying final (target) words in high- and low-context sentences at various levels of background noise. Low-noise condition SNRs and high-noise condition SNRs were created for each age group (3 dB harder for each increasing age group). Listeners were assigned to one of the two noise conditions. Overall, Fallon et al. (2002) reported that all listeners, regardless of age, identified the target words in the high-context sentences more accurately than the low-context sentences, and more accurately in the lower noise conditions than higher noise conditions. Whereas 5-year-olds performed poorer than the older participants, they still benefitted from context in the presence of background noise. This suggests that noise does not impede children's use of contextual cues. A goal of the current study is to extend these results by examining context effects for foreign-accented English sentences in 5- through 7-year-old normal-hearing children.

Individual Differences: Temperament

Children encounter speakers with nonnative accents frequently so it is important to understand what influences their ability to perceive this phonologically and phonetically varying speech signal. One possible contributing factor that has not been explored is temperament.

Temperament is defined as "constitutionally based individual differences in reactivity and self-regulation, in the domains of affect, activity, and attention" (Rothbart & Bates, 1998, p.100). 'Constitutionally based' refers to temperament being inherent to an individual from birth; that is, it has a biological basis (Eggers et al., 2010). 'Reactivity' refers to an individual's responsiveness to changes in the environment, and can be measured by threshold, intensity, latency of response, and the rise and recovery time (Rothbart & Bates, 1998; Zetner & Bates, 2008). This includes an individual's response to fear and negative emotionality. Self-regulation is an individual's ability to control and modulate reactivity (Rothbart & Bates, 1998). Temperament is seen as the core of personality (Rothbart & Bates, 1998), and can be modified by heredity, maturation, and experience (Eggers et al., 2010; Rothbart, Ahadi, Hershey, & Fisher, 2001; Strelau, 1983). Traits are not continuously expressed, but rather are elicited by appropriate conditions (Rothbart & Bates, 1998).

Rothbart and Bates (1998) proposed that temperament traits show consistency over time, but traits exhibiting stability still can change over time in the way they are expressed. For example, a 6-year-old spends less time crying than a 6-month-old, but spends more time worrying (Rothbart & Bates, 1998). Temperament contributes to the development of social-emotional and personality profiles (Rothbart & Bates, 1998). Some children may be more responsive to reward, while others are more responsive to punishment, implicating temperament in social learning. Coping strategies are also developed under the influence of temperament (Rothbart & Bates, 1998).

According to the Neural Model of Temperament developed by Rothbart & Bates (1998), temperament is constructed by three broad factors: Surgency, Negative Affect, and Effortful Control. Surgency is part of the reactivity domain and contains scales of positive emotionality such as approach, high intensity pleasure, activity level, and negative scales of shyness (Eggers et al., 2010). Surgency is a child's tendency to approach new situations in a positive emotional state, and

contains scales of positive emotion (Eggers et al., 2010). Negative Affect is the second and final factor in the reactivity domain and consists of scales of negative emotion including fear, discomfort, anger/frustration, sadness, and negative scales of soothability (Eggers et al., 2010). The self-regulation domain consists of the factor Effortful Control, which consists of scales of attentional focusing, attentional shifting, and inhibitory control (Eggers et al., 2010). Effortful Control is an individual's ability to regulate her/his attention, and inhibit dominant responses for subdominant responses (Eggers et al., 2010; Zetner & Bates, 2008). Children who have higher loadings on the approach scales of surgency will be more open to meeting strangers, compared to children with higher loadings on the fearful scale of negative affect who therefore develop strategies to avoid strangers (Rothbart & Bates, 1998).

Temperament has been studied in related fields as a potential influence on speech and language development and differences. Eggers et al. (2010) found significant differences between typically developing children and children who stutter in the composite factors of Negative Affect and Effortful Control when using the Dutch version of the Children's Behavioral Questionnaire (Van den Bergh & Ackx, 2003). Children between the ages of 3- and 8-years-old who stuttered had lower scores on scales of inhibitory control and attentional shifting, and had higher scores on scales of anger, frustration, approach, and motor activation compared to age- and gender-matched peers who were typically developing. Salley and Dixon (2007) found a correlation between children who scored low on scales of executive control and high on negative affect, and language development in 51 21-month-old infants using the Early Childhood Behavior Questionnaire (Putnam, Gartstein, & Rothbart, 2006) and the MacArthur-Bates Communicative Development Inventory, Words and Sentences version (Fenson, Dale, Reznick, Thal, & Pethick, 1994), which is a vocabulary measure. Temperament has also been studied as a possible influence on the

development of psychopathological disorders. Bijittebier and Royers (2009) presented evidence that all three temperament domains (surgency, negative affect, and effortful control) play a role in the onset, development, and maintenance of anxiety disorders.

Purpose and Hypotheses

The primary purpose of this study on children's perception of foreign-accented word-in-sentence recognition in background noise was to investigate the role that child temperament contributes to individual differences in the perception of foreign-accented speech.

We hypothesized that children with better native and nonnative speech recognition abilities will score lower on the Negative Affect domain (specifically anger/frustration scales) compared to children with poorer speech recognition abilities. In addition, we hypothesized that children with better native and nonnative speech recognition abilities would score higher on the Effortful Control domain compared to children with poorer speech recognition abilities (specifically, higher on scales of low intensity pleasure, inhibitory control, attentional focusing, attentional shifting, and excitatory control). Because children will had to focus their attention not only on the task at hand, but also on a single talker in the midst of background noise, it was predicted children with higher loadings on scales of attentional focusing, inhibitory control, and attentional shifting would perform better than children with lower loadings on these scales. The experiment took place at an interactive science center; therefore, we predicted that children who had a greater capacity to sit and complete the experiment (excitatory control) and those who found enjoyment in this low intensity, novel task (low intensity pleasure) would perform better than children with the opposite characteristics. Lastly, we hypothesized children who achieved higher scores on the native and foreign-accent conditions would demonstrate lower scores on the Extraversion/Surgency domain (specifically lower on the scales of high intensity pleasure and shyness). It was hypothesized that

children who were more outgoing (lower loadings on the shyness scale) would be more willing to interact with the researcher (a stranger) and actively participate in the experimental task. It was also hypothesized that children who found less enjoyment in high-intensity activities would perform better on this physically low-intensity task.

A secondary purpose was to evaluate if children benefited from semantic context in their perception of non-native speech and, if so, to determine whether the size of the benefit differed between native and nonnative speech. We hypothesized that children would benefit from semantic context and that the benefit would be greater for native than for nonnative speech.

II. Method

A. Participants

Data from 84 monolingual 5- through 7-year-old children (42 males and 42 females) with normal parent-reported speech, language, and hearing recruited from the general population at the Center of Science and Industry in Columbus, Ohio were used in this study. Nine additional participants were excluded from final data analysis due to: significant exposure to a foreign language (n = 3), speech, language, or hearing disorders (n = 1), or inability to complete the experimental task (n = 5). The participants were stratified into three age groups: 5-year-olds (n = 28, mean age = 5;4 SD = 0;3), 6-year-olds (n = 28, mean age = 6;6, SD = 0;4), and 7-year-olds (n = 28, mean age = 7;5, SD = 0;3). An equal number of female and male participants were included in each age group. Prior to participation in the experiment, all parents/legal guardians of participants provided informed consent and children provided verbal assent. Participants were not paid for their participation. This study was approved by the Ohio State University institutional review board.

B. Stimuli

Stimuli consisted of 60 sentences selected from the Wildcat Corpus of Native and Foreign-accented English (Van Engen et al., 2010). This database includes scripted and spontaneous speech recordings from native American English speakers and nonnative speakers of English. From this corpus, one male native English speaker and one male Mandarin-accented English speaker were selected (each spoke all 60 sentences). Thirty of the sentences contained final words that were highly predictable based on semantic context, whereas the other 30 sentences were not predictable from context. The final words of the 30 high-predictability sentences were the same as those of the low-predictability sentences. For example, the target word "coach" appeared in "The team was trained by their coach" (high-predictability) and "We read about the coach" (low-predictability). All 60 sentences are listed in Appendix A at the end of this paper. Only the final words were scored. Sentences were mixed with 8-talker babble at a +8 dB SNR. Noise began 500 ms before the sentence and continued until 500 ms after the sentence ended. The SNR was selected based on pilot data that indicated that it achieved a mean score of approximate 70% final-word correct in the native condition.

C. Procedure

Within each age group, half of the participants were randomly assigned to one of two conditions (native or foreign-accent condition). They were presented with all 60 sentences (30 high- and 30 low-predictability sentences) by one of the speakers – either the native or the foreign-accent speaker. Children were seated individually in front of a Dell Optiplex 790 desktop computer and presented the sentences under Audiotechnica headphones (model 8TH-770COM) binaurally in a semi-quiet room. A custom-written Python script controlled stimulus presentation. Sentences were presented at a comfortable loudness level. Listening began with four practice sentences (two high- and two low-predictability, one of each spoken by the native speaker and one of each by the

nonnative speaker) to familiarize the children with the task. Upon completion of the practice trials, the child was presented with all 60 sentences from a single talker in quasi-random order. The child's task was to listen to each sentence and repeat out loud exactly what she/he heard. The research assistant then keyed the child's response into the computer program and advanced to the next trial when the child was in a ready state. No feedback was given in regards to the accuracy of the listener's response; however, the researcher provided the child with non-contingent verbal praise after each item. The duration of the experimental task was approximately 15 minutes.

While the child participated in the experimental task, a parent filled out a language background questionnaire, in which she/he indicated the extent of the child's exposure to foreign languages and foreign-accented English. No listeners included in the data analysis had reported levels of frequent exposure to Mandarin-accented English (the foreign accent used in this investigation). In addition, parents filled out the very short form of the Children's Behavioral Questionnaire (VSF-CBQ) (Putnam & Rothbart, 2006). The VSF-CBQ is a caregiver report of temperament for children between the ages of 3 and 8 years old. The questionnaire is composed of a series of 36 statements the parent ranks on a 7-point Likert scale ranging from "extremely untrue of your child" to "extremely true of your child." The scale also features a "Not Applicable" option. The VSF-CBQ is constructed in reference to the standard CBQ; using the three most consistent factors of Surgency, Negative Affect, and Effortful Control. The VSF-CBQ is beneficial for researchers who are limited in participant resources, and wish to look at temperament in a multivariate investigation. The VSF-CBQ was chosen as the instrument of choice in this investigation because it takes 1/5 the time to administer than the standard CBQ - taking only 15 minutes. Putnam and Rothbart (2006) found that the very short form exhibited "satisfactory internal consistency and criterion validity" and "exhibited longitudinal stability" (p.103). The

items included on the VSF-CBQ (arranged into the factors/scales they each measure) are listed in Appendix B.

III. Results

1. Speech Perception Results

The children's speech recognition data were scored for final word identification accuracy for both high- and low-predictability sentences. Responses were evaluated with a strict scoring criterion: words with added or deleted morphemes were counted as incorrect. The data were analyzed with a Mixed Factorial ANOVA (Within-Subject Factor: Context; Between-Subject Factors: Age and Accent). The native English speaker was identified with higher accuracy than the foreign-accented speaker, $F(1, 78) = 128.54$, $p < .0001$, as shown in Figure 1. Figure 2 displays the final word recognition accuracy in percent correct for each of the two semantic context conditions. Words in high-predictability contexts were identified with higher accuracy than those in low-predictability contexts, $F(1, 78) = 65.564$, $p <. 0001$. Age significantly influenced word-in-sentence recognition, $F(2, 78) = 12.515$, $p <. 0001$ as shown in Figure 3. Post-hoc tests with a conservative Bonferroni correction for multiple comparisons revealed that 6-year-olds ($p = .005$) and 7-year-olds ($p < .0001$) had higher word-in-sentence recognition scores than 5-year-olds. No significant interactions were found.

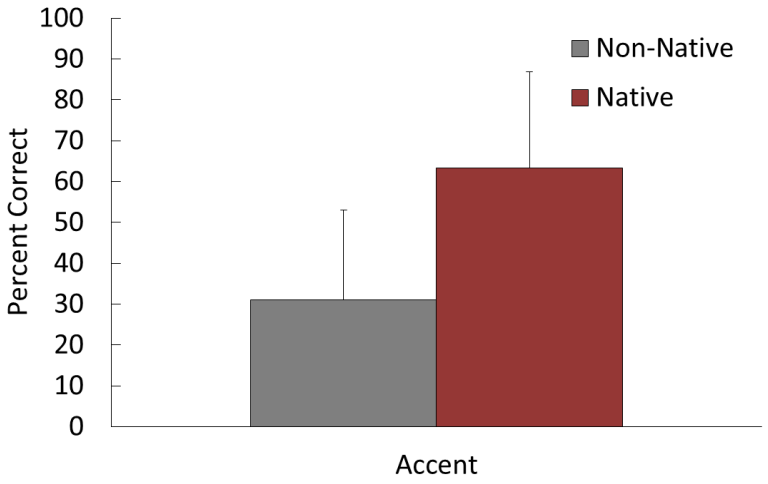

FIGURE 1. Mean final word recognition accuracy in percent correct (+1 SD) as a function of accent.

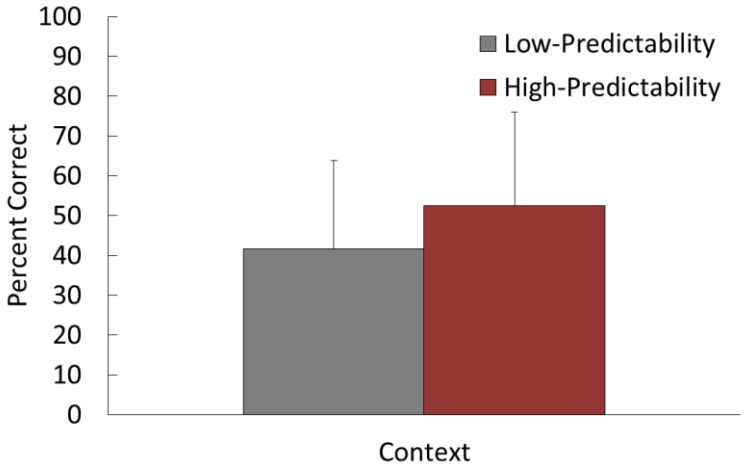

FIGURE 2. Mean final word recognition accuracy in percent correct (+1 SD) for each of the two semantic context conditions.

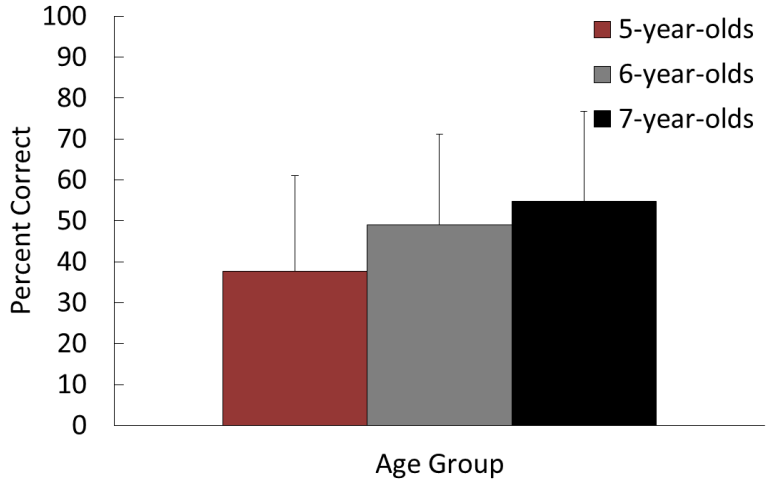

FIGURE 3. Mean final word recognition accuracy in percent correct (+1 SD) as a function of age group.

2. Temperament Results

The three individual temperament scales (Surgency, Negative Affect, and Effortful Control) were analyzed with regression/correlation analyses. The full regression model was not significant in either the high- or low-predictability conditions for the native or foreign-accented speakers. However, individual temperament scales were significantly correlated with spoken word-in-sentence recognition scores. For ease of reporting, the two predictability conditions were combined into a single averaged score for each listener. For listeners in the native condition, Surgency was correlated with word-in-sentence recognition (r = -.264 p = .045). For listeners in the foreign-accented condition, Negative Affect approached being significantly correlated with word-in-sentence recognition (r = -.226, p = .075).

IV. Discussion

Children's Perception of Foreign-Accented Speech

Our results, which revealed that participants had more accurate word-in-sentence recognition in the native condition compared to the nonnative-accented condition, are consistent with current literature suggesting that foreign-accented speech and unfamiliar dialectal speech is more difficult for listeners to perceive than native speech (Adank et al., 2009; Rogers et al. 2004; Nathan, Wells, & Donlan, 1998). Furthermore, these results contribute to the smaller body of literature suggesting that children in this age range observe difficulty similar to adults when listening to a foreign-accented speaker (Bent, 2014).

The secondary purpose of this study was to examine if children benefit from semantic context when listening to native and foreign-accented words-in-sentences in the presence of background noise, and if so, if there was a difference in the benefit between native and foreign-accented speech. The main effect of semantic context shows that listeners' achieved higher word-in-sentence accuracy scores when the target word was in a high-predictability sentence compared to a low-predictability sentence. There was not, however, a significant difference in the benefit of semantic context between the native and nonnative conditions. In other words, context effects were similar across the native and nonnative speaker conditions.

Fallon et al. (2002) studied native English word-in-sentence identification of 5-year-olds, 9-year-olds, and adults with varying semantic context (high- and low-predictability final words) and noise (high noise or low noise) levels. Results showed that whereas 5-year-old children performed more poorly than the older children and adults on the word-in-sentence identification task, listeners of all ages identified the target word more accurately in the high-predictability

sentences compared to the low-predictability, and at lower noise levels than at higher noise levels. The effect sizes were similar in children and adults.

Some studies have shown that listener's reap less benefit from semantic context when listening to unfamiliar dialectal speech compared familiar dialectal speech (Clopper, 2012) and in unfavorable listening conditions (Bradlow & Alexander, 2008). Clopper (2012) found that when adult listeners were presented with unfamiliar dialectal speech, the listeners relied relatively less on semantic information compared to familiar dialectal speech. Bradlow and Alexander (2008) found that nonnative speakers of English could only benefit from semantic context in an acoustically favorable stimulus (clear speech compared to plain speech) when listening to a native English talker. One possible explanation for these differences across these studies is the different talkers used in them.

Again, the present study did not find differences in the context effect between the two accent conditions. Here we analyzed the perception of foreign accented speech, whereas Clopper (2012) studied the perception of unfamiliar dialectal speech, and Bradlow & Alexander (2008) studied the perception of native accented speech in native and nonnative listeners. A secondary explanation for these differences is that the participants in the Clopper (2012) and Bradlow and Alexander (2008) studies were adult listeners, whereas the listeners in the present study were children.

Temperament

The primary purpose of our study was to examine whether significant differences in the three individual composite temperament factors could be attributed to individual differences in the perception of foreign-accented speech. Our findings reveal that two of the temperament dimensions (Surgency and Negative Affect) were correlated with children's speech perception.

The findings suggest that children with certain temperament profiles might have a tendency to perform more poorly on difficult tasks of speech perception. Children with higher loadings on the Surgency scale (enjoyment in high-intensity activities, outgoing, and high activity level) and higher loadings on the Negative Affect scale (feelings of anger, frustration, sadness, and discomfort) tend to be at a disadvantage on difficult tasks of speech perception.

Surgency is the positive emotionality domain of temperament and includes the scales of impulsivity, shyness, activity level, and high intensity pleasure. There was a trend for children who are more impulsive, outgoing, highly active, and find more enjoyment in high intensity activities to perform significantly more poorly on the task of native speech perception. As predicted, children with a strong need for high-intensity pleasure are less likely to do well on this low-intensity speech perception task than children with lower drive for such high-intensity activity. This was a low-intensity activity, requiring the listener's to transition from a noisy, interactive science center, to sitting at a computer listening to sentences under headphones for fifteen minutes. This task of speech perception was a low intensity activity so children with a strong need for high intensity pleasure appeared to do more poorly on it.

Negative Affect is the negative emotionality domain of temperament and includes scales of anger, discomfort, sadness, soothability, and fear. There was a trend for children who are inherently more fearful, sad, uncomfortable, angry, and difficult to soothe to perform more poorly on this task of foreign-accented speech perception. The perception of foreign-accented speech is particularly challenging, so children who have a natural tendency to become easily frustrated or angry performed poorer on this task. In addition, children who inherently tend to be more uncomfortable may not respond well to performing a novel task, in a novel environment with a stranger (researcher).

Our findings are some of the first to investigate temperament as a possible contributor to individual differences in children's speech perception. Currently, most research working to account for individual differences in speech perception has focused on cognition. Aspects such as inhibition, working memory, and auditory attention have been linked to poor spoken language outcomes in children with cochlear implants (Pisoni, Conway, Kronenberger, Henning, & Anaya, 2010). In addition, Lalonde and Holt (2014) found that working memory is related to speech discrimination in normal-hearing children. Temperament, however, is unique because it is completely unrelated to cognition.

Understanding temperament as a possible contributor to children's speech perception abilities is important because a child's temperament is something inherently brought to the task. Temperament is part of the child's personality and is something moderately stable throughout the lifetime. In addition, temperament is measurable through caregiver reports. The very short form of the Children's Behavioral Questionnaire (Putnam & Rothbart, 2006) only takes parents 15 minutes to complete and provides researchers and other professionals with an accurate profile of the child's temperament. The short period of time required to complete this form allows for it to be administered to caregivers easily and efficiently. Lastly, it is potentially possible to accommodate for temperament by professionals in testing and therapeutic settings. Future work will evaluate whether accommodating for specific temperament profiles in testing methodology will lead to changes in spoken word recognition scores. For example, children with high loadings on the Surgency scale (and thus, who have a need for high-intensity activities and physical movement) might experience gains in spoken word recognition scores if the task is made more physically active and highly rewarding and exciting. Similarly, if the child has high loadings on the Negative Affect scale, perhaps accommodating for the child's innate tendency to be frustrated by providing

a large amount of positive feedback and their tendency to be fearful by waiting to assess speech perception abilities until the child is more familiar with the tester and the environment, would lead to higher spoken word recognition performance. If future work reveals such trends, it would have consequences for how clinicians carry out testing clinically. In other words, testing methods could be tailored for the individual child based partially on temperament to reveal their maximum performance under ideal conditions.

This was a promising first study accounting for individual differences in children's temperament profiles in relation to speech perception. Future research is needed to more fully investigate the role of temperament in spoken word recognition. One potential area for future research would be to use multiples SNRs or more difficult test materials to examine if certain areas of temperament are more influential as the task difficulty varies.

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APPENDIX A: High and Low Predictability Sentences

High Predictability Sentences	***Low Predictability Sentences***
Elephants are big animals.	He pointed at the animals.
A pigeon is a kind of bird.	We pointed at the bird.
The war plane dropped a bomb.	Dad talked about the bomb.
A quarter is worth twenty-five cents.	He pointed at the cents.
We heard the ticking of the clock.	She looked at the clock.
The team was trained by their coach.	We read about the coach.
Many people like to start the day with a cup of coffee.	Mom pointed at the coffee.
February has twenty-eight days.	There are many days.
Last night they had beef for dinner.	He talked about the dinner.
My parents sister and I are a family.	We read about the family.
A racecar can go very fast.	She thinks that it is fast.
The good boy is helping his mother and father.	Mom pointed at his father.
People wear shoes on their feet.	Mom looked at her feet.
When sheep graze in a field they eat grass.	Dad pointed at the grass.
I wear my hat on my head.	She pointed at her head.
At breakfast he drank some orange juice.	Mom looked at the juice.
In spring the plants are full of green leaves.	She talked about the leaves.
People wear scarves around their necks.	She talked about their necks.
For dessert he had apple pie.	Mom talked about the pie.
She made the bed with clean sheets.	Data talked about the sheets.
Rain falls from clouds in the sky.	Dad read about the sky.
The sport shirt has short sleeves.	He looked at the sleeves.
Football is a dangerous sport.	This is her favorite sport.
A book tells a story.	We looked at the story.
A wristwatch is used to tell the time.	This is her favorite time.
Birds build their nests in trees.	He read about the trees.
He washed his hands with soap and water.	We talked about the water
Monday is the first day of the week.	This is her favorite week.
Bob wore a watch on his wrist.	He looked at her wrist.
The color of a lemon is yellow.	Mom thinks that it is yellow.

APPENDIX B: List of 36 statements on the VSF-CBQ by scale (Putnam & Rothbart, 2006). "R" indicates question was reverse scored.

Surgency	***Impulsivity***	7. Often rushes into new situations. 19R. Takes a long time in approaching new situations. 31R. Is slow and unhurried in decided what to do next.
	Shyness	10. Seems to be at ease with almost any person 22R. Is sometimes shy even around people s/he has known a long time. 34R. Sometimes turns away shyly from new acquaintances.
	Activity Level	1. Seems always in a big hurry to get from one place to another. 13R. Prefers quiet activities to active games. 25. Is full of energy, even in the evening.
	High Intensity Pleasure	4. Likes going down high slides or other adventurous activities. 16. Likes to go high and fast when pushed on a swing. 28. Likes rough and rowdy games.
Negative Affect	***Anger***	2. Gets quite frustrated when prevented from doing something s/he wants to do. 32. Gets angry when s/he can't find something s/he wants to play with.
	Discomfort	5. Is quite upset by a little cut or bruise. 20R. Hardly ever complains when ill with a cold. 29R. Is not very upset at minor cuts or bruises.
	Sadness	8. Tends to become sad if the family's plans don't work out 17. Seems to feel depressed when unable to accomplish some task. 35. Becomes upset when loved relatives or friends are getting ready to leave following a visit.
	Soothability	14. When angry about something, s/he tend to stay upset for ten minutes or longer. 23. Is very difficult to soothe when s/he has become upset.
	Fear	11. Is afraid of burglars or the "boogie man." 26R. Is not afraid of the dark.
Effortful Control	***Inhibitory Control***	6. Prepares for trips and outings by planning things s/he will need. 18. Is good at following instructions. 30. Approaches places s/he has been told are dangerous slowly and cautiously.
	Attention Focusing	3. When drawing or coloring in a book, shows strong concentration. 15. When building or putting something together, becomes very involved in what s/he is doing, and works for long periods of time. 27. Sometimes becomes absorbed in a picture book and looks at it for a long time.
	Low Intensity Pleasure	9. Likes being sung to. 21. Likes the sound of words, as in nursery rhymes. 33. Enjoys gentle rhythmic activities, such as rocking or swaying.
	Perceptual Sensitivity	12. Notices it when parents are wearing new clothing. 24. Is quickly aware of some new item in the living room. 36. Comments when a parent has changed his/her appearance.

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